DEVELOPMENT OF LEARNING RESOURCES TO PROMOTE KNOWLEDGE SHARING IN PROBLEM BASED LEARNING

By

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ABSTRACT

Problem Based Learning offers many benefits to students' learning, however, the design and implementation of effective problem based learning (PBL) is not trivial. Central to effective implementation of PBL are the problem design and group working of the students. Design of good problems requires that the learning outcomes of the subject are covered in the problem given. Effective problems should include all learning outcomes as well as make sure that the resources are available. Group working is an essential part of PBL. However, group work among students is not easy. For learning to be effective, the group must share knowledge and engage in their learning; It is vital that the group functions well and everyone takes up his or her role. In reality students often find group working difficult and they prefer to work on their own. This paper describes design and group issues that need to be addressed for PBL to be effective and successful. Furthermore, it includes a case study of the implementation of learning objects in a virtual learning environment to support PBL on a final year undergraduate module in microcontroller interfacing.

Keywords: Problem Based Learning, learning outcomes, VLE.

INTRODUCTION

PBL enables students to apply knowledge from different subject areas, to collaborate with others, to think critically, to reflect on their own learning, to communicate and to learn-to-learn. It involves goal setting, planning, execution, monitoring and evaluation and the problem is typically anchored in an authentic setting. PBL comprises learning activities that involve an in-depth study of the subject by a group of students working together to solve the problem. PBL provides an environment for students to investigate issues that address real world problems while integrating subjects from different disciplines of the curriculum. The environment enables students to interact and share their knowledge as a team. This also gives students the opportunity to learn negotiation skills, team working skills and communication and problem-solving skills.

In problem based learning, the tutor takes the role of a coach or facilitator to monitor learning. The tutor probes or challenges the students' thinking, manages the group dynamic and learning process to make sure that all the students in the group are engaged and participating in sharing knowledge to resolve the given problem. During the tutorial process, the tutor facilitates the learning process by posing meta-cognitive questions such as, "What assumptions have you made?" "What did you do?" "How do you know?" etc. PBL thus fosters active learning, supports knowledge construction and integrates learning with real-life situations (Torp and Sage, 2002).

Crucial to the success of PBL is the design of ill-structured, often inter-disciplinary problems (Savery, 2006). It is important to design problems that are realistic and reflect real-world situations. Most problems in life are not simple, but ill-structured and have no single correct answer. These problems require students to consider alternatives and then provide a reasoned argument to support the solution(s) they derive at the end of the learning process (Hmelo-Silver and Barrows, 2006).

Design of PBL Problems

The starting point of PBL is a problem statement, which is often called a trigger. The trigger starts the PBL case and prompts the development of learning issues (Uden and Beaumont, 2006). The trigger is formulated as a problem, query or puzzle that the team has to investigate. The problem statement is one of the keys to the successful implementation of PBL. If the problem does not stimulate

the student's interest or enable students to generate learning issues that relote closely to the desired learning outcomes, then there are likely to be difficulties with both teom work ond ochieving the leorning outcomes.

There are several factors that need to be considered when designing problems for PBL. They are i) Firstly the problems should be as realistic os possible so thot students can have the experience of working on problems that they will foce in real life. ii) The problem should be designed in such a way that there should be synthesis of knowledge and skills from different disciplines. iii) The problem should cover all the learning issues thot students are expected to learn. iv) The problem should be chollenging so thot students can develop problem-solving, critical thinking and metacognitive skills. V) The problem should be achievable within the timescale of the PBL module.

Stimulotion of thinking, analysis ond reasoning are the most important characteristics of good problem design. Studies have identified the following process for developing problems or triggers for PBL (Uden ond Dix, 2004); (Uden, 2005).

- Start with the learning outcomes (or learning objectives).
- Look for possible problems that involve the subject learning outcomes.
- What learning issues will the students generate?
- Thinking through the process.
- Resource review.
- Write a facilitotor's guide.
- Final review with colleagues.

Central to the above process is the provision of resources for students during PBL, in particular for technology students. The following section briefly reviews how the use and evaluation of learning resources and VLE help in the design of our PBL for students.

Evaluation of Learning Resources and VLE in support of the PBL

The aim of the case study reported here is to provide an evaluation of the observed outcomes of the development and implementation of leorning objects to support PBL. They were used in conjunction with a virtual leorning environment (VLE) for the delivery of a microcontroller interfocing module in the final yeor of an undergroduate product design ond technology course. The objective of this is to find out how this can be used to enhance the learning and teaching experience of the students. This was conducted through discussions with students, feedback through assessment and course evaluation. Such outcomes enabled the teaching team to expand the scope of the module content to encompass more advanced applications of microcontroller interfacing and control. The VLE was developed to supplement and enhance the existing learning and teaching experience ond not solely replace lectures, tutorials and laboratories. Students could elect not to use the virtual learning environment and still porticipate in learning as poper-bosed handouts and resources were olso given to the students.

The leorning resources used in this work comprised tutor-generated resources, student generated resources and a strategy for assessment. The tutor-generated resources consisted of lecture notes with corresponding slideshows, supplementary notes, simulations, video-based media, links to relevant websites and scanned versions of articles (with copyright permission). Such student-generated resources comprised electronic schemotic designs, assembly code programs, analysis of circuit function and detailed explanotion of microcontroller program execution.

The Virtual learning Environment (VLE) - learn@lboro

The VLE is a virtual space where learning, assessment and interaction can toke ploce in a structured and managed way fully integrated into and linking university wide information systems. It provides student-level information comprising university-wide informotion on university procedures and regulations and support services. More importantly the VLE provides links to modules, tutors, lecture materials and course related news olerts. Course and module informotion is provided through portal news and bulletins. Each module has its own dedicated website which is structured such that the staff can provide

news; create, uplaad and link ta teaching materials; hast on-line discussions; set and receive assignments; upload reading lists; obtain class lists and organise, as well as set, anline graup wark. The VLE pravides a mechanism taward jained up systems ar systems integratian by creating links "seamlessly" to other systems such as web servers (departmental and central), 'Learn' and the university library resaurces system.

Learning objects: Hypermedia-Based Tutorials and Self Assessment Laboratories

The hypermedia-based tutarials accessible fram the VLE provide a valuable learning resource as they clearly provide instructions to the student in the use of the PIC pragramming enviranment MPLab® IDE. The laboratories and downloadable resources are solely accessible from the VLE. The emphasis here is to enable the use af the VLE as much as passible in the delivery af this module. The self-assessment laboratories, developed by the author, provided the students with the ability to perform a series of staged checks within the teaching and learning af micracantraller interfacing. This enabled the students to assess themselves with respect to the theoretical background to the subject. These self-assessment tutarials were essentially a series of self-assessment tutarials and circuit canstructian exercises that were accessible from the VLE.

The PBL Activity Design Project

Fram week seven anwards, the students were grauped into pairs and worked on a design project within the module which required designing and making a small twa wheeled buggy ta fallaw a black line an a white background. This required designing electronic interfacing for light detection inputs and motor control and speed autputs fram the micracantraller. The design praject emphasised the approach of learning technology through design which is a vital aspect of this work.

Discussion of Observations

Through observation and module evaluation it was found that these resources enabled students ta work at their awn pace thraugh such tutarials withaut the fear af falling behind the scheduled milestones and learning outcomes each week within the module. This provided differences in learning rates and styles amang the graup af students. The design praject played a significant rale in putting into practice what had been learned in the laboratories using the circuit construction exercises. This appraach enables the students ta manage their learning in an arganised and structured manner, the hypermedia-based approach tends to appeal to students as they have became quite accustamed ta use internet as a research and learning resaurce.

The virtual learning enviranment cantains all the lecture slides and nates far the students ta relate the thearetical foundations of microcontroller interfacing with the pragmatic emphasis af digital and analague circuit design and canstructian. It was alsa faund that students tended to explore the subject further than was done before the implementation of this approach to teaching and learning. There have been advantages in utilising these approaches to the delivery of this module.

Evaluatian af this madule was undertaken by administering a questionnaire to both year groups. This questionnaire sought to elicit learners' views and respanses with regard ta a number af issues relating ta the use of the 'learn' server, the approach ta teaching and learning on this module and the quality as well as the quantity af work required for the module.

Knowledge sharing in groups

We believe that learning is an incremental process and knawledge creatian is a constructive pracess rather than a finding one. PBL involves the canstruction of knawledge through interdependent social participation. Learning in PBL involves a recipracal pracess, where students as individuals cauld influence the graup and the graup could influence the cognitive development theory and acquisition skills of the individual student.

Knowledge sharing is important in learning for students. In order to have effective knowledge building among students, it is impartant that the students share knowledge between themselves. Knowledge sharing is the exchange of information in order to yield knowledge.

Knowledge is considered a private good, owned by the individual and its development and exchange occurs through one-to-one interaction (Wasko and Faraj, 2000). However, students ore often reluctant to share knowledge. Many are not hoppy to contribute to group work for fear of giving away their valuable assets for the benefit of others. Students often find knowledge sharing difficult.

How do we motivate and encourage them to share knowledge in learning?

In PBL the students discuss the problem, generate hypotheses based on the experience they hove, identify relevant facts in the case, and learning issues. The learning issues are topics of any sort, deemed of potential relevance to the problem and which the group members' feel that they do not understand as well as they should. For effective learning, students must work in groups and share knowledge. The first author of this article has implemented Problem-Based Learning (PBL) since 1996 (Uden, 2004). Central to the PBL tutorial sessions is that students should work in groups to insight the problem, identify leorning issues and determine solutions for the given problem. Group working and knowledge sharing ore crucial to the success of the problem. Initially most students found group work difficult and were reluctont to trust the other members and share their knowledge. The author has been investigating ways of helping groups to work effectively so that they can trust eoch other to share their knowledge. Lock of trust was one of the main barriers to the groups working effectively at the start of the tutorial sessions.

In PBL, to solve problems, collaboration by the students in o group requires knowledge sharing. Knowledge sharing is where one disseminotes one's acquired knowledge with the other learners in the team. People only share their knowledge if they think that the knowledge would be useful and importont to others. There ore several factors that are important to facilitate knowledge sharing among students in PBL. These are: solidority, sociobility and trust. Trust is the most crucial of the three.

Solidarity is the measure of the members of the community or organisation to pursue shared objectives, regardless of personal ties (Goffee and Jones, 1996). A joint sense of purpose or objective is vital. Even if members did not know eoch other, o sense of solidority of objective brings them together to oct as one. Students must take ownership of their own learning by recognising that they share the some objective - that is to solve the problem. This gives them a sense of response to competitive encroaches and a low tolerance of poor performance.

It is also important for us to promote sociability among the groups. Sociobility is the amount of sincere friendliness among members of the group. Here members are more like friends than classmates. Social supports must be presented to creote a dynamic climate for positive growth in groups. It is important to show a caring attitude towards each individual in the group. This con be achieved by taking a personal interest in monitoring the progress of eoch member of the group os well as taking interest in octivities outside of the tutoriol sessions. This also helps members to develop trust. This social aspect has greot impact in knowledge sharing because members began to view each other as friends and were happy to share ideas and knowledge as well as sustain a high level of unarticulated reciprocity. Each member of the group was motivated and committed to work for the benefits of the group.

People do not share knowledge where there is no trust (Alstyne, 2005). People are ofraid to shore because they do not trust others (Standing and Benson, 2000). Trust can be an enabler or disobler of knowledge management, depending on how individuols interact. Trust facilitotes cooperative behaviour (Shneiderman, 2000). Trust is defined as the expectotion thot arises within a community of regular, honest and cooperative behoviour, based on commonly shared norms, on the port of the members of the community (Fukuyamo, 1995). Trust is central to define the informational needs of on individuol in meeting expectations within and between relationships (Luhmann, 1979). It is argued, however, that there is an inverse relationship between trust and the need for knowledge, and that trust is an alternative to information

or knowledge (Tomkins, 2001). It is perceived by many researchers that trust and knowledge exchange are positively related (Wicks et al., 1999) and (Edwards and Kidd, 2003). It is our belief that successful transfer of knowledge depends on the direct porticipation of both the giver and the recipient of knowledge.

Context plays a crucial role in trust and knowledge. Knowledge, particularly tacit knowledge, can only be transferred through social activities (Nonako ond Takeuchi, 1995). Trust can be developed across remote project teams by the creation of a social context through initially swapping information omong teom members (Jarvenpoa and Leidner, 1998). Knowledge is not a physical commodity, but is an ongoing social accomplishment, constituted ond reconstituted in everyday practice (Orlikowski, 2002). Similorly, trust is also a dynamic process. As knowledge increases through the practice of sharing and giving, so as trust is nurtured (Styhre, 2002). Knowledge grows rather thon diminishes with use. Trust also grows with use. An obvious relationship was found among the students between trust and knowledge shoring.

Each of the students participating in the PBL groups came from a different background, had different interests, and possessed different knowledge. Although they were different, all participated in a community of practice (Love and Wenger, 1991). All of these students porticipated in on activity system in which they shored understanding concerning what they were doing and what this means in their lives and for their communities (groups). Whot was importont is that the members of such communities were porticiponts in a common activity. Therefore it makes sense to use community of practice to study the relationship between trust and knowledge shoring.

The PBL group acts as o community of proctice comprised of individuals who are related to each other by virtue of their common engagement with an activity, the solving of the problem. To each individuol member of the group, the sharing of knowledge and the trust that sharing both requires ond creates were importont parts of their community life. For students, to share knowledge effectively is crucial to the success of PBL, especiolly in group work. Trust is critical if knowledge sharing is to be achieved. From the experiences of the researchers in working with students on PBL, the authors identified several kinds of trust thot are relevant for knowledge sharing among students.

Firstly, competence-based trust is essential for the group to work effectively. It is trust that describes o relationship in which on individual believes that another person is knowledgeable about a given subject area. (Sharratt and Usoro, 2003). Besides competence-based trust, there is benevolence-based trust. This is trust in which an individual will not intentionally horm another when given the opportunity to do so. There is also capacity trust, which is reloted to the degree to which it is believed that an individuol is capable of using the knowledge correctly. The group may possess the required expertise in a certain area, but it may be believed that it has not the capacity to use the expertise effectively because of another's inobility to communicote. (Sharrott and Usoro, 2003).

Trust in integrity is important because it relotes to the degree to which it is believed thot an individual or community behaves decently and honestly. This may be related to trust in value. (Ashleigh et al., 2003). Trust in volue is olso important in our findings. It is reloted to the degree to which it is believed that an individual or community possesses one's own values. Perceiving that another party does not share one's own values leads to distrust of that party (Sitkin and Roth, 1993).

How do we facilitate trust?

It was found that trust con be promoted by:

1) Creating a common understanding of how PBL leorning works: The researchers felt the importance of developing a common context or common understanding among students regarding the nature and goals of the course. Factors thot were significont in building benevolence and competence based trust include shared language and goals, and relote to the importance of building a shored view of how learning wos accomplished, how it is measured and how it is ultimately rewarded. Creating this common

understanding makes it easier to focus on mutually held goals and values. This helps to reduce time and effort spent on individual issues and motivation (Shneiderman, 2000).

2) Helping to build trust-building behaviour: Tutors can influence the level of trust by modelling and recognising trust-building behaviour, such as receptivity and discretion.

The researchers believe that it is important to provide a rich social and organisational context in the learning environment so that trust can be developed between the tutor and the students. It can be seen that there is a relationship between trust and knowledge sharing among the students. Trust facilitates knowledge exchange, leading to more extensively shared knowledge, which in turn facilitates the development of trust. The studies between groups of students in the PBL communities show that, everything else being equal.

- The greater trust between individuals, the greater sharing of knowledge between members.
- The greater shared knowledge between individuals, the greater the trust between them.
- The extent that the different types of trust are promoted is dependent on the knowledge shared and context.
- The extent of the promotion of trust by shared knowledge is context-dependent.

Besides the above mentioned issues, others factors such as networking, motivation, competence, incentives, community of practices and others also can impact on knowledge sharing. It is important that research should be conducted to address many other issues that can have impact on knowledge sharing.

Conclusion

This case study provided an insight into the observed outcomes of using a virtual learning environment in tandem with using learning objects for the support of a microcontroller interfacing module of a product design and technology undergraduate degree course. It has been found, since its introduction, the VLE has been greatly appreciated and widely used by students in general. It almost seems that when given a task, their first point of reference is the internet and by utilising the VLE in the teaching of this module it has become a proven and useful tool for the teacher and student alike. There are several important factors that have impacts on knowledge sharing for students in learning. There is the issue of solidarity as students must be aware of the same objective in their learning if knowledge sharing is to be effective. Unless students know what their roles are and take ownership of the shared objective, it is difficult to have effective sharing among them. Another issue is that of sociability. It is important to encourage social interactions and have facilities to promote activities that foster friendship. Last, but not least important is the issue of trust. Trust is vital for successful knowledge sharing.

Central to this is to understand the relevant context for knowledge sharing. The context within which knowledge is being shared comprises social, organisational and technical issues that can be analysed at different levels of abstraction. The temporal interconnections need to be taken into account explicitly. It is therefore important to analyse processes rather than entities in knowledge sharing.

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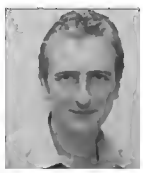

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